Outline of plant genetic resources conservation course

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I. GENETIC RESOURCES CONSERVATION:PRINCIPLES

1. Introduction to terms and concept

1.1 Acquisition-introduction, exploration, field collection, exchange, deposit

1.2 Preservation vs. conservation

1.3 Germplasm=genetic resources, cultivars(cvs.), breeding stocks, genetic stocks (testers), gene -pool

1.4 Genetic erosion, threatened status, extinction

1.5 Genetic conservation activities (narrow sense) — collectin/introduction/exchange, multiplication /regeneration, characterization, preliminary evaluation, preservation (incl. duplicate storage), documentation, distribution, counselling

1.6 Extension of conservation activities-evaluation, research (agricultural, biological, evolutionary, historical, social-economic), germplasm enhancement (prebreeding), breeding, commercial use (incl. biotech), environmental protection

1.7 Genetic conservation of plant genetic resources (PGR) is a young field in plant science. Being a young technology, it draws on many other disciplines (botany, cyto-genetics, breeding, physiology, pathology, entomology, seed science, production technology, biochemistry, statistics, ecology, anthropology), and other related fields of study to improve its effectiveness and efficiency. On the other hand, providing service to others should be our motto. Scientific cooperation should be reciprocal.

2. Why conserve?

2.1 Continuous human need for new gene-pools to meet increasing/expanding demands for quantity, quality, production efficiency

2.2 Immediate needs in food production: resistance to new pests/ biotypes and emerging complications, tolerance to abiotic stresses (extreme temperatures, flood, drought), tolerance to pollutants, quality improvements, ease in production/post-harvest handling, expansion into new areas of cultivation

2.3 Medium-to long-range targets: reinstatement of genetic diversity, new crops, tolerance to

new environmental stresses (water scarcity, salinization, intensified UV radiation)

3. What to conserve?

3.1 A pair of nucleotides (a gene)

3.2 Pure-lines (strains)

3.3 Variety (cultivar, cv.; plural, cvs.);

3.4 Land races (farmer's varieties, primitive forms)

3.5 Related wild species (often more conceptual than authentic wild species)

3.6 Weed races (mixture of hybrids among wild, cultivated and their hybrid progenies)

3.7 Related genera

3.8 Weed species in cultivated fields

4. Spectrum of germplasm in a crop species (cultigen) and its wild relatives

4.1 Germplasm from primary area(s) of diversity--primitive cvs., wild relatives, weed races, related genera, co-evolved weeds

4.2 From production areas--commercial cvs. (some selected), obsolete cvs. of the past, minor or special cvs.

4.3 From breeding and research programs: pure-lines from farmer's cvs., cvs. of hybrid origin, F_1 hybrids, breeding lines, breeding stocks, mutants, genetic testers, aneuploids, polyploids, composites/synthetics, cytoplasmic sources, molecular markers.

5. Genetic composition, productivity level and potential usefulness

5.1 Intra-populational diversity vs. commercial worth and genetic potential (see Chang, 1985, T.1, p.340-1)

5.2 Can we foresee all the needs?

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II. CONSERVATION SYSTEMS AND METHODS

1. Conservation approaches

1.1 Ex-situ conservation - genebanks (seed banks), field and screenhouse nurseries, in vitro cultures, cryogenic tanks, botanical gardens/arboreta

1.2 In situ, conservation - natural reserves, genetic reserves, on-farm and backyard plantings, tribal areas

2. Conservation systems

2.1 Crop-specific collections (often in national crop institutes)

2.2 National collections, incl. foreign introductions(in ant'l agric. res. center or nat'l PGR center)

2.3 International collections (in int'l agric. res. centers=IARCs)

2.4 Private collections (of seed industry or product consortium)

2.5 Smaller collections in experiment stations, colleges and schools, cooperatives, public parks and gardens

Recent trend: consolidated collections from small ones, national plant germplasm systems, international network of genebanks.

3. Conservation methods related to genetic structure of the crop and storage characteristics of propagative parts

3.1 Seed storage characteristics

3.1.1 Cold and dry storage for orthodox seeds

3.1.2 Specific manipulations for non-orthodox(recalcitrant) seeds, e.g. wet storage, cryogenic storage of embryo, short ened life cycle. See Ford-Lloyd and Jackson, 1986, T.4.3, P.58 59, for a list of spp. having such behavior.

Also see Cromarty et al, 1982, p.22-31.

3.2 Vegetatively propagated plant parts (clones)-in field nurseries, screenhouses, pots, store-room with controlled temperature and humidity

3.3 in vitro storage of cells and tissues, with or without growth retardant

3.4 Cryogenic storage in liquid nitrogen at -196℃ or higher-- for meristems, pollen grains, small seeds

The choice of a storage method should consider ease of operatin, cost, and success in regeneration Attention should be given to genetic changes during storage (stability). Viability of stored materials should be periodically monitored.

4. Seed storage of different types of germplasm

4.1 Base collection -- A comprehensive collection of irreplaceable germplasm materials

(landraces, obsolete varieties, wild relatives, genetic testers/stocks, breeder's seed of recommended cvs.) held under long-term storage conditions (-18℃ to -10℃, below 30% RH, 4-6% seed m.c.). Stored seeds will not be readily distributed, except for regeneration or emergency use.

4.2 Active collection -- A subset of the base collection that is frequently used for evaluation, research and breeding.

Regenerated as often as needed. Stored under medium-term storage conditions: 0℃ to 5℃ degrees, about 50% RH, seed m.c. around 10%. Smaller subsets intended for wide testing as representatives of the whole collection are core collections or core subsets.

4.3 Working collection -- A variable collection of breeding stocks, breeding lines, released cvs. and other evaluated materials frequently used by the breeders. Stored under short-term conditions: 10℃ or above, 50% RH or above, seed m.c. above 10%; frequently regenerated and re-composed according to need

5. PGR centers vs. genebanks

A modern genebank is an essential component in a PGR center. The latter includes field nurseries, screenhouses or greenhouses, other auxiliary facilities.

Discussions on the design of a genebank and its components are provided by Cromarty et al (1982), Chang (1988)and Chang et al (1989). Management aspects may be found in CHang (1991a, b).

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III. SCIENTIFIC PRINCIPLES IN CONSERVATION AND UTILIZATION PRACTICES

1. Evolution of genetic variability and diversification

1.1 Origins of new variability: mutations (gametic, somatic), chromosomal changes (polyploidy, aneuploidy), cytoplasmic changes, interactions among the above following hybridization

1.2 Diversification: hybridization-recombination-differentiation cycles, natural and human selection in new environments

1.3 Human inputs: dispersal and selection -- a powerful force

2. Genetic composition of a plant community at the sub-species level

2.1 The pure-line theory

2.2 The population concept

2.3 What make up a variety (cv.)? What is in a variety name ?

2.4 Relation of mode of reproduction to genetic structure

2.5 Tests for genetic differentiation: morpho-agronomic, cytogenetic, physiological, biochemical, numerical, molecular differences

2.6 To isolate (purify) or to lump (keep as bulk)?

3. Essential practices in meeting users' demands and maintain genetic integrity

3.1 The conservation process begins with field collecting, followed by multiplication, initial observation and evaluation, characterization, comparison and selection, documentation (at all phases), processing for storage, dissemination of genetic material and information, to use - a long process that requires a systems- approach and care at every step, rather than isolated operations.

Timeliness in dealing with the fragile seed or plant parts is crucial. Speed and efficiency in dealing with large numbers are necessary. Team approach and team work is a must.

3.2 Who are the users? This affects certain practices.

3.3 The PGR worker should strive to be an active partner in crop research and breeding, rather than a silent servant. Participate in public-informing activities.

3.4 Plan seed increase/regeneration according to the mode of reproduction/propagation of the crop species and the needs (in quantity). Pay attention to population structure and intra-population polymorphism

3.5 Sample/population size should be sufficiently large to justify the laborious process and to avoid genetic drift.

3.6 Evaluated accessions have more value to users. While growing plants, watch out for novel features, and re-grow to ascertain heritable nature.

3.7 Try to follow up on the use of seeds/plants provided - the PGR worker will learn a lot.

3.8 Make faithful records of your activities and observations.

3.9 Watch out for environmental changes that affect plant growth and reproduction -- such observations will help your next planting, esp. when two planting seasons are feasible.

4. Plasticity in germplasm and their malleability

Surprisingly, even self-fertilized plants contain large genetic variability. The variability is expressed when grown in a different environment. Clonal materials are highly heterozygous -- revealed when sexually propagated. A plant scientist can re-mold the materials by crossing and selecting under new/different environments within a short time. Even without the sexual cycle, a worker can alter some of the gene- combinations in a strain by repeated selection in a different environment -- that is how eco-strains are produced.

5. The human factor

PGR conservation, leading to effective use, is a long and labor- intensive process. Human inputs, together with the germplasm collections and physical facilities, are the cornerstones of this crucial and unglamorous mission. All the world over, the quantity and quality of PGR workers are in short supply. Therefore, it is imperative to develop and support competent and dedicated PRG workers.

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IV. EVALUATION AND DOCUMENTATION

1.Evaluation - an essential step to use in breeding and related research

1.1 Prerequisites: seed or plant material; methodology based on earlier research; breeding-oriented approach (large nos., efficient operations); verifiable findings (and use statistics); serial tests (from mass screening to refined tests); team approach (multi- disciplinary interaction).

1.2 Methodology: sample sizes, test environment and extent of control; controls (biological, agricultural), replications for verification; dealing with probable duplicate accessions and ecostrains; expanding the scope; continuous improvement; seeking cooperation from researchers; use 'hot spots' for large-scale screening.

1.3 Cautions: do not let pests/wild spp. escape into the fields; beware of different population structure in test materials.

1.4 Advice: Although evaluation is generally outside the primary duties of PGR workers, but active participation as co-worker or adviser will prove to be rewarding. Adopt the systems-approach.

2. Documentation - an indispensable component in every facet of a conservation program

2.1 Data files: fields → records → files

2.2 Passport (basic) data. Collection details; accession no., acc. name ; former designatin; seed source; origin; ecco-agro data taken at collection site or breeding history

2.3 Characterization data (mostly morpho-agronomic)

2.4 Seed-related files: seed increase; inventory, distribution; viability monitoring, regeneration records

2.5 Use standard descriptors and decimal scoring system, other international codes

2.6 Plan for computerized entry and management of data files at the beginning of a program, Also plan for inter-station linkup.

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V. GERMPLASM REGENERATION, RE-IDENTIFICATION AND USE

1. Regeneration -- a necessary evil

1.1 Why regenerate? Arising need, expiry of old stocks

1.2 Hazards in regeneration: human mistakes, errors in operations, introduction of mixtures, genetic drift, adverse weathers, past damage #

1.3 Essential measures: checking and rechecking (of records, seed, seed file/specimens before planting, plants in the field; harvested materials); adequate size of plots; control of pests and weeds; removal of off-types; careful handling at all stages; aiming for sufficient harvests for restocking and duplicate storage at other site(s)

1.4 Opportunities for disease elimination; new studies and planning for re-collection to maximize benefits from this costly and laborious operation

2. Re-identification

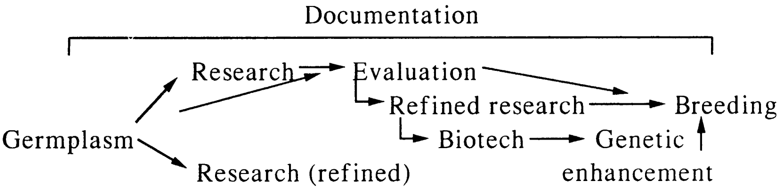
2.1 Why re-identify? To ensure authenticity of genetic material acc.

2.2 Prerequisites: earlier informatin (seed file, characterization data; manpower, facilities and planting space; experience and expertise

2.3 Methods: checking against characterized data, seed file, specimens file or photos; comparing life plants, biochemical tests (specific chemicals, isozymes, molecular markers)

3. Use (esp. of exotics)

3.1 The process



3.2 Handicaps to full use: user's unfamiliarity with germplasm; lack of information; obvious flaws; breeder's focus on highly heritable traits control led by a few major genes; unavailability of plant material or seed; intellectual property restrictions

3.3 PGR worker's role - PGR workers can serve a powerful role in helping all other disciplines in using novel germplasm.

My advice to co-woekers: Never plant the last seed!

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VI. NATIONAL PLANT GERMPLASM SYSTEMS AND INTERNATIONAL CROP CENTERS

1. Selected examples of national plant germplasm systems

1.1 The NPGS of the US (see Janick, 1989 and NRC, 1991)

Participating agencies: USDA, State Agric. Experiment Stations.

Management: National Program for Germplasm, guided by a committee appointed by the Secretary of Agriculture.

Component units: 4 Regional Plant Introduction Stations, National Seed Storage Laboratory, Crop-specific Collections (small grains, soybean, flax, cotton, potato), 8 Clonal Germplasm Repositories, Crop-specific Genetic Stocks Collections, National Germplasm Research Laboratory, Plnat Introduction Office. Assisted by the Animal and Plant Health Inspection Service.

Total holdings: about 600,000, of which more than 514,000 are P.I. from foreign sources.

National-wide information sysem: GRIN (Genetic Resources Information Network) in National Germplasm Res. Lab. Strength; size of collections, competent staff, good service, inputs from Crop Advisory Committees; international character. Weakness: insufficient government support (until recently), widely scattered units and diffused image.

1.2 Japan (see Nakagahra, 1994)

The crop germplasm collections are cared by the MAFF (Ministry of Agric., Forestry & Fisheries) Genebank System managed by the National Institute of Agrobiological Resources (NIAR).

The main bank with excellent facilities is at the NIAR. 14 subbanks are in different institutes and centers of MAFF. 43 prefectural research units with medium-term storages look after specific crops that these stations have expertise.

Total holdings: about 200,000. Distribution to foreigners, rather restricted.

Several plant collections for special studies are in the universities, under the Ministry of Education. Status not clear.

1.3 Mainland China (see Rockefeller Foundation, 1980; Zhang and Dong, 1989)

Large-scale field collections were made 1956-58. All scientific activities stopped during the Cultural Revolution. Crop workers managed to pool and sent seeds to a make-shift storage house in Sinkiang, which act saved most of the materials. Re-collections were made since early 1980s. The National Institute of Crop Germplasm Resources (NICGR) was estabilished in Peking in 1978.

The Rockefeller Foundation helped to build a modern long-term storage lab (completed in

1986) which can hold 400,000 acc.

Duplicate sets of crop seed are held in medium-term storage at various crop institutes and NICGR. For 10 years, germplasm conservation received top priority in 5-yr Plans. Now PGR units are set up in every provincial academy of agricultural science. PGR workers may share 10% of the prize for outstanding cvs. bred from their germplasm.

Foreign distribution: v restricted and difficult.

2. International crop germplasm collections and their linkages

There are about 18 international centers in the Consultative Group on International Agricultural Research (CGIAR) system, of which 10 commodity-oriented centers and the IPGRI (Int'l) PGR Inst.. formerly the IBPGR) are involved in germplasm work. The IPGRI is primarily a coordinating agency, helping national and international PGR centers It has made significant inputs in field collecting, standarding descriptors for various crops, sponsoring meetings on technical aspects and regional cooperation, training, and publishing. The other 10 IARCs are the work horses, handling germplasm collecting, preservaiton, exchange, training, and use.

The 10 IARCs are:

CIAT (Centro Internactional de Agricultura Tropical), AA 6713, Cali, Colombia, dealing with beans, cassava, and forage legumes and grasses. Noted for tissue culture work on cassava.

CIMMYT (Centro Int'l de Mjoramiento de Maiz y Trigo), POB 6-641, Mexico, DF 06600, Mexico - famous for its semidwarf wheats and less so for maize. Its wheat collection is largely breeding material; maize germplasm once v. good and mostly lost due to neglect; now recollecting.

CIP (Centro Int'l de la Papa), A.5969, Lima, Peru -- now handles both common potato and sweet potato, noted for tissue culture mass propagation and virus elimination.

ICARDA (Int'l Center for Agric. Res. in Dry Areas), POB5466, Aleppo, Syria -- handles barley, lentil, faba been, durum wheat, wild wheat spp., chickpea

ICRISAT (Int'l Crops Res. Inst. for Semi-arid Tropics), Pantancheru PO, AP 502324, India -- handles sorghums, millets, pigeon pea, chickpea, peanuts.

IITA (Int'l Inst. of Tropical Agriculture), PMB5320, Ibadan, Nigeria -- deals with yams, cassava, sweet potato, cowpeas, soybean, rice (African and Asian), Bambara groundnut. Some kept in invitro.

ILCA (Int'l Livestock Center for Africa), POB 5689, Addis Ababa, Ethiopia, has a forage grass and legume collection.

INIBAP (Int'l Network for the Improvement of Banana and Plaintain), Box 7, Montferrier-sur-Lee, France, has 1,000 acc. of Musa spp.

IRRI (Int'l Rice Res. Inst), POB 933, 1099 Manila, Philippines, is the first IARC in the system and has the largest collection of Asian, African and wild riees (total 82,000) Noted for its efficient management and complete line of services to users. IRRI also supplies improved/evaluated germplasm from breeding and int'l testing programs.

WARDA (West Africa Rice Development Association), BP 2551, Bouake, lvory Coast; has 8,500 rice acc. at 3 stations. Used to be in Liberia; reorganized and moved to lvory Coast.

Remarks: The 10 IARCs have served a most useful roles not only in conservation but also as centers of exchange. The IPGRI claims to have an "int'l netowrk of genebanks" but it only works in rice and in Europe. The FAO has recently assumed the trusteeship for the collections at the IARCS -- on paper. The sad truth is that many small national collections of rice (also of other conserved crops) have expired -- genetic erosion inside genebanks. The stored set at the IARCs and USDA are the last suriviving materials. Even the famous Vavilov Institute of Russia is depending on foreign help to keep it running.

IPGRI's efforts to promote regional cooperation in South Asia and East Asia have been unrewarding. Only the workers in Indonesia, Malaysia, Philippines and Thailand of SE Asia had collaborated on massive field collecting missions, mostly on horticultural crops; but no followup action to evaluate, store and consolidate, The collected materials ended largely as dead specimens -- a lesson we should note.

Wide-ranging interest in genetic conservation follow the "heat wave" concern for evnironmental protection in the 1960s. PGR projects got help from donor agencies. The intense activities in rice partly derive from educating the public and decision-makers on the importance of PGR conservation; in turn, national governments became interested and several genebanks in Asia were built with JICA or USAID funds. Meanwhile, agitators of the politico-socio activists upset the relation between the South and the North for several years. But at the end, the USDA benefited from the heightened attention on PGR

*Most of the rice accessions of IITA and WAARDA are in the IRRI genebank.

Looking back, those crop collections enjoying the best care were assembled and cared by a small number of dedicated and persevering scientists who treated the plants like their children. e.g., potato, tomato, small grains in the U.S., wheat in Germany, and rice at IRRI. May the world have more of them to protect the biological heritage that will feed the burgeoning world in the next century and beyond. You may be the ones.

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VII. REFRIGERATION AND DEHUMIDIFICATION FOR SEED STORAGE

1. Basic concept

1.1 Nearly all crop seeds are hygroscopic -- they absorb and lose (desorb) moisture from the surrounding air, depending on the differential between the seed m.c. and the RH of the air.

1.2 What is RH? It is also a function of ambient temperature.

1.3 Cooling is easier to attain than drying at low temperatures.

1.4 Both cooling and drying are slow and expensive processes.

1.5 Effective insulation and air tightness of the storeroom (walls, ceiling, door and floor) are equally important.

1.6 Properly dried seed and tight seed containers ensures seed long evity and vitality of stored seed.

2. Refrigerating equipment

2.1 Basic components

For cooling: motor-driven compressor (piston or rotary), refrigerant (Freon), connecting pipes for hot vapor, condenser, cooling device for condenser (air or water), receiver and pipes for hot liquid, evaporator (coils, brush and air fan), return (suction) line for cold liquid thermostat, insulation for pipes and joints where the coolant (Freon or chilled water) passes.

Essential accessories: drip pan, drain pipe, air fans, heating elements for de-icing or dehumidification, air filter for return air, damper for fresh air, exhaust fan, temperature and RH recorder, lights, and alarm.

2.2 Other important accessories: fire-fighting equipment, security devices, emergency generator, emergency lights, intercom.

3. Dehumidification (also applicable to seed drying)

3.1 Methods for dehumidifying storage rooms

3.1.1 Mechanical refrigeration -- most effective at high temperatures and high RH, the first step; ineffective in lowering RH below 50% and below 20℃

3.1.2 Desiccants - silica gel, lithium chloride -- slow, low water- absorption capacity (for silica gel), slow to reactivate (redry), esp. in the humid tropics

3.1.3 Re-heating system built into the refrigerating equipment -- effective and efficient at low temperatures

3.2 Seed drying

Sun drying is not recommended - may damage seed due to uneven heating and radiation

damage.

Dry heat in an oven is better, but never exceed 40℃.

Low heat (e.g. below 30℃) drying with the help of a rotary type lithium chloride impregnated wheel (the Munter brand) is used at IRRI.

The IBPGR recommends 10-15℃ with forced ventilation of 10-15% RH air for small seeded spp. I find it impractical: the environment is difficult to reach or maintain; the process is too slow for genebanks which deal with large nos. (more than 1 month). For very low seed m.c, result, better use 2-stage drying. The RH of air in the drying room also affects drying efficiency when drying ovens are used.

4. General remarks

In addition to good refrigeration and drying equipment, other factors should be considered: insulation (also against roof and wall leaks during prolonged raining), airlock area (preferably cooled and dehumidified with portable machines), frequent checking of sealing materials on pipe connections, base of cabinet walls, door, etc., esp. after earth-quakes and typhoons. Separation of dry and wet areas. Vigilance pays. Also saving money!

It is important for a genebank manager and his staff to understand the principles of cooling and drying and thus be able to communicate with refrigeration workers in solving problems.

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GLOSSARY

accession. A variety or a strain or a bulk population registered at the genetic resources center for conservation. Two or more morphologically or ecologically different accessions may have the same name.
一份收藏品

acative collection. A subset of the comprehensive (base) collection that is actively used for research, evaluation, and breeding, often regenerated according to need.
常用材料品

adaptability. The ability to adapt to different environments by modifications in physiological responses.
適應性

adaptation. The process of becoming adapted to new or different environmental conditions or for particular functions.
適應過程

adaptiveness. Degree of being adapted to a certain environment or environments.
適應程度

alleles. One of two (or more) alternate forms of a gene located at a certain position (locus) on a particular chromosome or linkage group. When the number of alternate members exceeds two, the alleles form a multiple allelic series.
等位基因

allelism. The relationship between alleles in different parents. When the alleles of two parents belong to the same gene (locus), they are allelic; otherwise, non-allelic.
等位性

allozvmes. A subset of isozymes that are allelic variants of the same isozyme locus.
等位同功異構酵素

base collection. A comprehensive collection preserved by long-term storage.
全套材料

biodiversity. The diversity of biotic components in an ecosystem.
生物岐異

biological species. A group of populations that potentially share a gene-pool and are reproductively isolated from other such groups in nature.
生物(態)種

biotic environment. The insect pests, plant pathogens, weeds, other crop plants, small animals and microbes in the habitat comprise the biotic phase of environment.
生態環境

bulk. The growing and maintenance of genetically different plants in a population without separating them into pure lines or appying selection efforts.
混合群體

chromosome. Self-duplicating units of genetic material which are species specific in number and complexity as physical carriers of the genes.
染色體

clone. A vegetatively propagated strain that produces identical progenies.
營養繁殖系

collection. An assemblage of collected samples; a collected sample.
蒐集品，收集樣本

conservation. The planned management of a natural resource to deter or prevent overexploitation, irreversible destruction, or neglect. Conservation should allow further evolutionary changes.
保育

core collection. A subset of a base collection sampled in such a manner so as to represent the larger collection.
核心材料

cryopreservation. Preservation in liquid nitrogen.
超低溫保存

cultigen. A cultivated crop species.
栽培作物

cultivar. A cultivated variety; the international term for variety.
栽培品種

data base. A collection of related data files.
資料庫

descriptors. Morphological and other traits to be recorded.
性狀描述

descriptor-states. Coded or actual values taken on a trait.
性狀值

puplicate samples. Collected samples from different sources which belong to the same variety as indicated by name, site of collection or origin, and morphoagronomic characters.
重複樣本

eco-strains. Strains within a variety that have developed physiological differences in response to repeated planting and selection in other environments.
生態品系

ecosystem. A functional system including organisms of a natural community together with their environment.
生態系制

elite germ plasm. Breeding stocks including cultivars of hybrid origin, breeding lines, hybrids of single or multiple crosses, bulk populations, and composite populations.
選育種質

ex situ conservation. Conservation outside the natural habitat.
異地保存

exotic germplasm. Landraces, special types and wild species.
稀罕種質

gene. The genetic unit controlling the inheritance of a character (trait). A character may be
基因 governed by one or several genes.

genebank. In a narrow sense, the preservation portion of a genetic resources center; often used
基因庫 exchangeably with the latter.

gene-pool. Total genetic information possessed by the reproductive members of a sexually
有性繁性生物 reproducing population. Gene-pools are classified into primary, secondary
基因園 and tertiary

gene-pools. Desired genes or gene-complexes in genetically diverse populations.
可用基因園

genetic base. The amount of genetic variousness available to the breeder or farmer among widely
遺傳基層 grown cultivars in relation to the total variousness in a crop species. Cultivars with a broad genetic base can adapt more readily to changing environments or selection efforts than can a narrowly based one.

genetic composition. The constitution and proportion of genetically different individuals in a
遺傳組成 population.

genetic diversity. Existing condition of being genetically different.
遺傳差異性

genetic drift. An evolutionary process or man-directed act that changes the allelic frequencies
遺傳漂變 within a population due to random variations in births or deaths, or due to unitended selection. Genetic drift is more serious in small populations or their samples.

genetic erosion. Disappearance of individual geneotypes from farmers'fields, natural
遺傳流失 environments or genebanks.

genetic information. Heritable information contained in a particular sequence of nucleotides in
遺傳訊息 a DNA or RNA molecule.

genetic integrity. Maintaining the original genetic compositions of a population.
遺傳組織保全

genetic potential. The likelihood that the genetic material (improved or primitive) is capable of
遺傳潛力 producing many new genotypic combinations from stored variousness by hybridization and subsequent segregation, recombination, and selection under varying forces.

genetic resources. Germ plasm that includes the entire array of cultivars in the crop species,
遺傳資源 related wild species in the genus, and hybrids between the wild and cultivated species.

genetic resources center. An institution concerned with the overall conservation of a crop or
遺傳資源中心 crops.

genetic stock. A variety or strain known to carry one or more specific traits, though the genetic
遺傳材料 mechanism of such characteristics may not be so clearly understood as that of a genetic tester.

genetic tester. A pure line or hybrid known to carry one or mory genes that distinctly express
遺傳資分析材料 themselves in morphological or physiological features. The mode of inheritance of such traits is known by prior genetic experiments.

genetic variability. The ability to differ genetically.
遺傳變異性

genetic variation. The genetic process of varying.
遺傳變異

genetic variousness. Diversity among individuals within a species or a smaller subdivision of the
遺傳異樣度 species due to differences in genetic constitution (genotype).

genetic vulnerability. A condition in which major cultivars may suffer serious losses on account
遺傳危脆性 of their genetic uniformity and widespread adoption.

genome. Basic chromosome set of a diploid species.
染色體組

genotype. The genetic constitution or make-up of an individual organism; a group of individuals
基因型 having a common or specified genetic make-up.

germ plasm. The sum total of genetic material in a species and its close relatives; genetic
種質 information carried by the material. syn.: genetic resources.

heritability. Proportion of the total phenotypic variance that is genetic for a given given trait.
遺傳率

heterogeneous. Having different genotypes in a population. A heterogeneous population can have
具異質基因的 both homozygous and heterozygous individuals.

heterozygous. Hybrid for the different alleles of a gene or genes.
異質結合

homogeneous. Uniform in appearance and similar in genetic composition due to descent from a
具同質基因的 common ancestor.

homozygous. Having one type of allele in both chromosomes for a given gene or genes.
同質結合

in situ conservation. Conservation carried out in the natural environment of the original habitat.
原產地保存

isozymes. Different, but functionally similar forms of an enzyme, which can be determined by one or more loci. While isozymes of a given enzyme catalyze the same reaction, they differ in properties such as pH or optimal substrate concentration.
同功異構酵素

line. A strain; a family derived from one plant.
品系

landrace. A primitive, unimproved and often heterogeneous population of crop plants found in traditional agricultural systems resulting from long years of selection by farmers.
地方品種

locus (plural: loci). The position that a gene occupies on a chromosome.
基因座

off-types. Plants that differ in morpho-agronomic characters from the majority or representative plants of a variety; admixtures in a field; obvious contaminats such as tall plants in a semidwarf cultivar or vice versa.
雜型

oligogenic gene. A major gene of good expressivity and high heritability. Mendelian analysis of discontinuous traits generally involves major genes.
强性基因

orthodox seed. Seed adapted to cold-and-dry storage for a prolonged period.
耐貯型種子

passport data. Information taken on a sample during field collecting. Site, grower, ecogeographic features of site, special characteristics of cultivar, date and name of collectors are essential items.
基本資料

PCR (polymerase chain reaction). DNA polymerase is an enzyme that catalyzes the formation of DNA molecules from deoxyribonucleotides. PCR is an automated reaction for generation of large numbers of copies of any fragment of DNA, using polymerases. Very small strating samples can be amplified using PCR.
聚合酵素連鎖反應

phenotype. The appearance of an individual produced by the genotype in interaction with a given environment.
外表型

polygenes. Numerous genes that contribute to the continuous variation in a quantitative trait, each having samll and equal effect.
微效基因

polymorphism. Simultaneous and regular occurrence in an essentially homogeneous population of two or more types of variants that are genetically related.
多型性

population. A group of interbreeding individuals (plants) within a species or a variety that are found at one site or field. Plants in the population may or may not be genetically alike.
族群

primitive forms. Plants having primitive features such as pigmented plant parts, long awns, lax panicles, extreme shattering, and procumbent and perennial growth habit.
原始材料

pure line. A line that has been made almost completely homozygous by repeated self-pollination and selection of a specific type (or by the removal of off-types).
純系

recalcitrant (non-orthodox) seed. Seed that cannot tolerate drying and can only be stored for a short period in a wet condition.
不耐乾貯型種子

regeneration (rejuvenation). Further multiplication of germplasm material after the earlier stock is exhausted or expired.
更新

PFLP (restriction fragment length polymorphism). Variations within a species in the length of DNA fragments generated by a specific restriction endonuclease. RFLP markers are based on sequence changes in the recognition site of the endonuclease, i.e. from mutations that create or eliminate recognition sites for these enzymes. Separation RFLP fragments is done by electrophoresis. RFLP's show co-dominant segregation, greater allelic variation than for morphological markers, are phenotype-neutral, and are free of epistatic interaction. RFLPs can be used to assess genetic diversity, identify cultivars and germplasm, aid introgression of genes, identify and combine desirable genes, and select against undesirable linked genes.
限制片段多樣性

strain. A group of plants within a variety that share common, recognizable features in morpho-agronomic characters, physiological differences, or reactions to specific disease pathogens or insect pests. A strain may include several lines with similar features.
選系

sample. Individuals taken from a population to represent it.
樣本

variants. Related members of a population showing small but distinct genetic differences in one or two features.
變異體

varietal diversity. The extent of dissimilar varieties growing in an area.
栽培品種間變異性

variety. A group of cultivated plants within a species which is distinguished from another variety (group) by any characters (morphologic, physiological, biochemical, or other) of significance to agriculture and which, when reproduced, retains its distinguishing characteristics. A variety may be derived from several pure
栽培品種

lines which have many common features and are reasonably uniform in appearance (but not necessarily genetically pure). Syn.: cultivar.

weed races. Complex hybrid swarms resulting from the repeated intercrossing among wild species, cultivated species and their hybrid progenies.
似雜草種

working collection. A sizeable collection of evaluated accessions that are adequately stored, documented, and available for immediate use by the breeders; syn.: breeder's collection.
育種材料

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